

Physics Analysis - Status and Plans

The Standard Model

Fermions			Bosons
Quarks	u up	c charm	t top
	d down	s strange	b bottom
Leptons	ν_e electron neutrino	ν_μ muon neutrino	ν_τ tau neutrino
	e electron	μ muon	τ tau
			Higgs* boson
			Force carriers
			γ photon
			Z Z boson
			W W boson
			g gluon

Source: AAAS *Yet to be confirmed

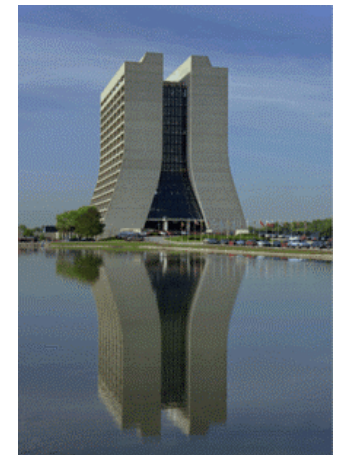
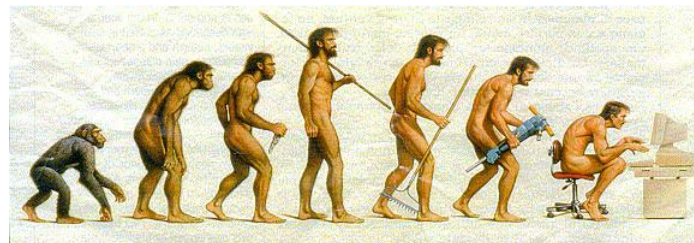
Boaz Klima

Fermilab

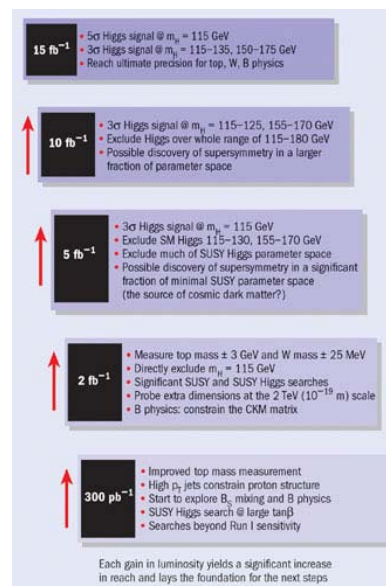


Collaboration Meeting

Feb. 12, 2003



You know we are doing well if...



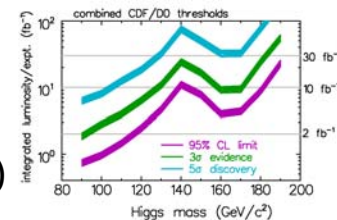
Or...

Higgs Sensitivity Study



- What? Why?

- We were asked by DOE to provide a new estimate/plot (based on "data", current understanding of analysis components, new ideas,...)
- Timescale ~ June/July '03 - no time for complete analysis!
- In parallel - DOE accelerator review and P5 Run IIb review
- The message (result and interpretation) should be crisp & clear
(+ there is more physics than just Higgs in 2/5/10/15 fb⁻¹)



- Strategy

- Formed a CDF/DØ working group (min overlap with current efforts)
(DØ Members: Babukhadia, Fisher, Goussiou, Klima, Narain, Partridge, Rizatdinova)
- Use the Run II Working Group study (hep-ph/0010338) as a basis
- Split the work wherever possible, e.g. CDF - lvbb, DØ - vvbb (the most sensitive modes), extrapolate intelligently to all other decay channels
- Add new channels, e.g. W/Z(/H?) decaying to τ , $H \rightarrow WW, \dots$ and combine

This study may turn out to be important

Introduction

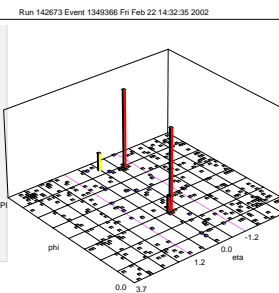
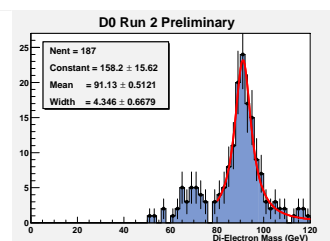
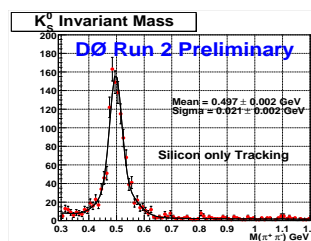
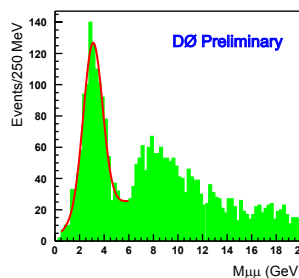
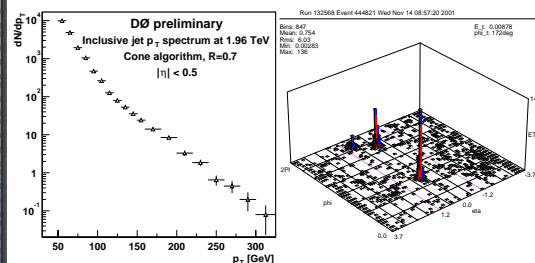
- Thanks to Jianming for agreeing to serve as a Deputy Physics Coordinator - excellent choice, great news (not only to me!)
- Things I'm not going to talk about this time
 - Trigger Board and Offline Resources Board - function very well! interact with many groups, help in planning and implementation, perform nicely under pressure, lively discussions, goal oriented
 - ID groups - worked extremely hard over the last several months, made great progress on many frontiers, advanced our understanding of the data, interacted well with detector and physics groups, certified objects, always "work in progress"

Sorry; no time for more details

What have we shown so far?



Moriond (Les Arcs, Mar. '02)

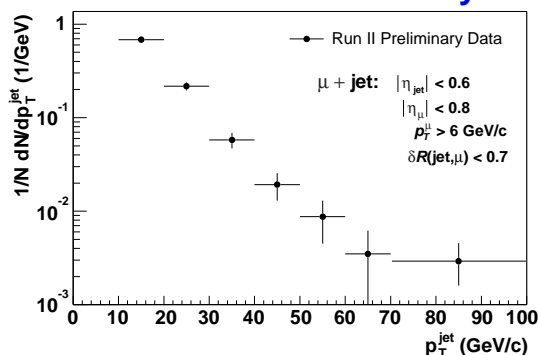


QCD (jets)

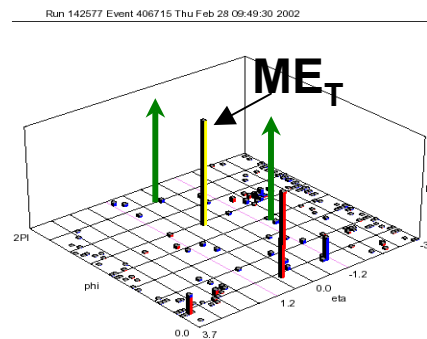
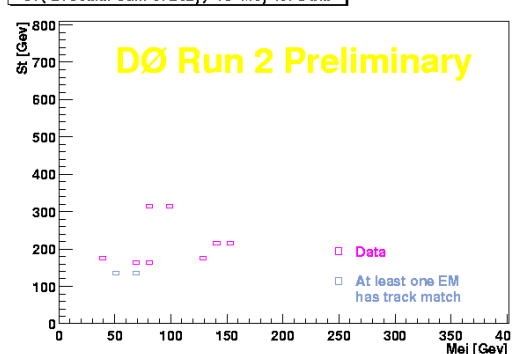
$J/\psi \rightarrow \mu^+\mu^-$ $K_S \rightarrow \pi^+\pi^-$

$Z \rightarrow e^+e^-$

D0 Run 2 Preliminary



St (Et scalar sum of 2e2j) vs Mej for Data



$\mu + \text{Jets}$

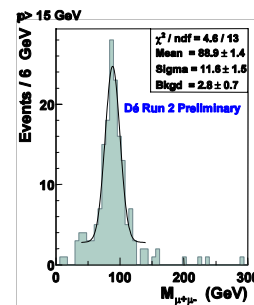
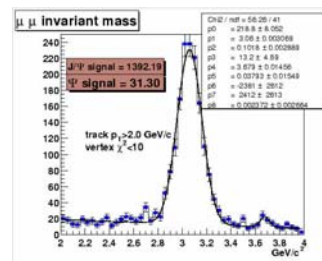
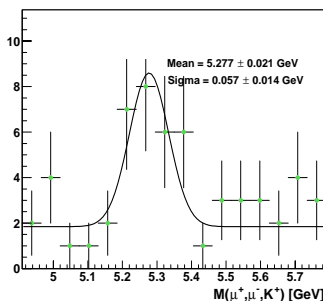
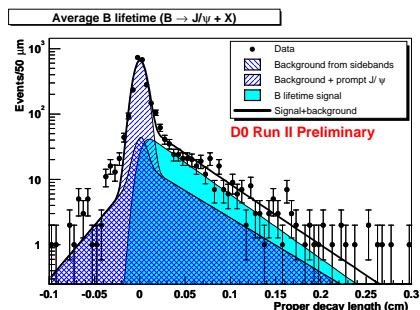
LQ search

$e\mu\mu$ candidate

Conclusion - ready to do physics ($\mathcal{L} \sim 1 \text{ pb}^{-1}$)

What have we shown so far?

ICHEP (Amsterdam, July '02)



Identify b quarks

$B^+ \rightarrow J/\psi K^+$

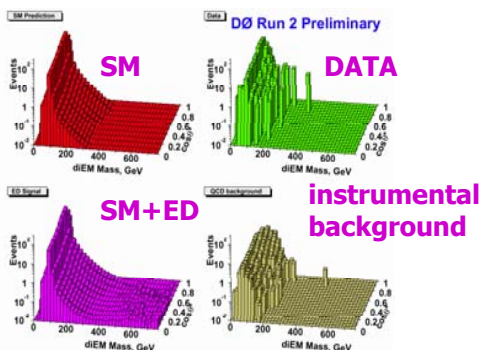
J/ψ and ψ'

$Z \rightarrow \mu\mu$

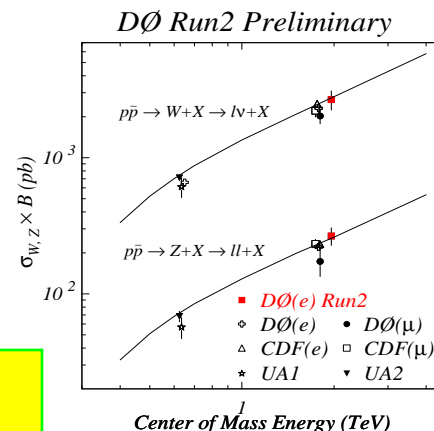
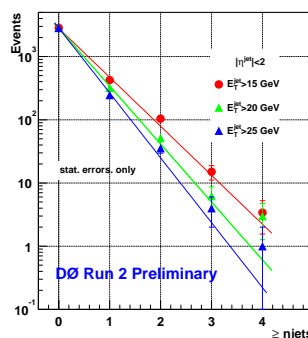
Extra Dimension Search

$W \rightarrow e\nu + \text{jets}$

W/Z prod. x-section



$M_s(\text{GRW}) > 0.92 \text{ TeV} (ee, \gamma\gamma)$

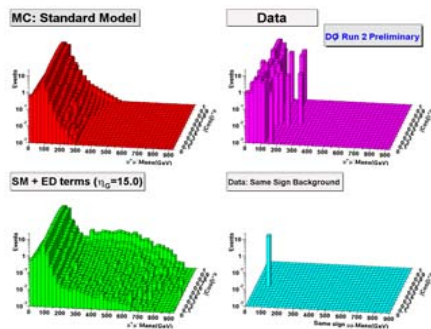


Conclusion - we are doing physics ($\mathcal{L} \sim 5 \text{ pb}^{-1}$)



What have we shown so far?

HCP (Karlsruhe, Sept. '02)

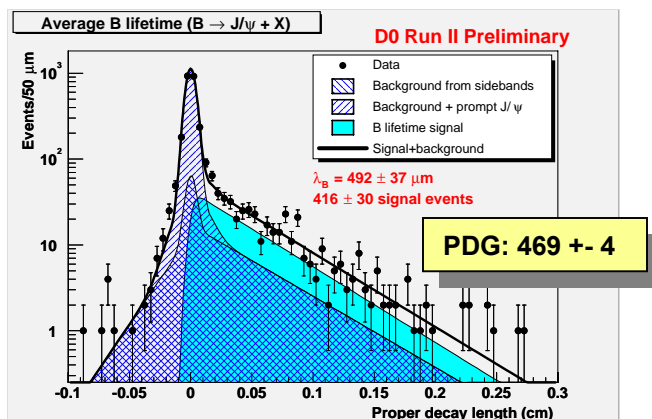


More New Phenomena Searches

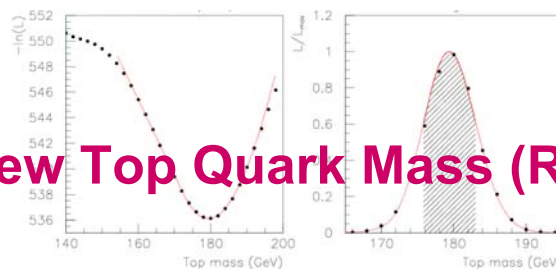
	eee	$ee\mu$
<i>SM Bkd</i>	0.9 ± 0.2	0.13 ± 0.08
<i>EM Fakes</i>	1.0 ± 0.3	0.6 ± 0.2
<i>Cosmics</i>	---	$.145 \pm .014$
Total	1.9 ± 0.4	0.9 ± 0.2
Data	2	1

$$\eta_G = (7.8 \pm 4.7) \text{ TeV}^{-4}$$

B Quark Lifetime



New Top Quark Mass (Run I)



$$M_t = 179.9 \pm 3.6 \pm 6.0 \text{ GeV}$$



Was 5.6 GeV in publication

Conclusion - we can do even more physics ($\mathcal{L} \sim 5 \text{ pb}^{-1}$)

The Overall Plan – Next Six Months



As presented at the Collaboration meeting on 10/9/02

- Basic requirements (some more crucial than others):
 - Detector and Trigger work adequately ~~✓~~ → ✓
 - Decent data-taking efficiency (>75% soon and increasing) ✓
 - Highest priority triggers not prescaled ~~✓~~ → ✓
 - Data reconstructed as they are collected (<2 weeks) ✓
 - Dataset of at least 50pb⁻¹ by the end of 2002 ✓
- More requirements:
 - Streaming available 
 - TARC recommendations implemented ✓ (more to come in p14)
 - Initial CTF recommendations implemented  (more in p14)
 - P13 ready for prime time early enough for reprocessing ✓
 - Backlog eliminated in time ~~✓~~
 - ...
 - Stability ~~✓~~

Overall we did quite well

The Overall Plan – Difficult Decisions



- We should keep the “right” balance between the need for results to be shown at conferences (+ feedback+ education+ excitement+...) and the need for making progress as fast as possible to get to the “big prize”
Hardware/Trigger/Software/Analysis
- Find the “optimal” timing for installation of new hardware/software/triggers, fixing problems, optimization, releases,...
- There is room for improvement
 - Guiding individual efforts
 - Coordination and planning
 - Monitoring of performance
 - Delivering the goodies
- Like any other big organization we are as good as our weakest link...

What we would like to show at Moriond '03



Aggressive Wish List (Oct. '02)

- Top Physics
 - Measure $t\bar{t}$ production cross section at $E_{CM}=2$ TeV
 - Measure Top quark mass
 - Other top properties?
- W/Z/Higgs Physics
 - Measure inclusive W and Z production cross section
 - Measure W+jets and Z+ jets production cross sections (b-tag?)
 - Demonstrate production of W decaying to τ
- New Phenomena Searches
 - Determine limits on the production of particles generated by a variety of physics beyond the SM (SUSY, LQ, ED, etc.)

Goals for Moriond '03 (cont.)



- QCD Physics
 - Measure inclusive jet production cross section
 - Demonstrate diffractive physics
- B Physics
 - Measure b quark lifetime
 - Measure b production cross section
 - Demonstrate observation of different B meson exclusive decay modes

It's very important to have a strong showing

message - we are beginning to do exciting physics ($\mathcal{L} \sim 50 \text{ pb}^{-1}$)

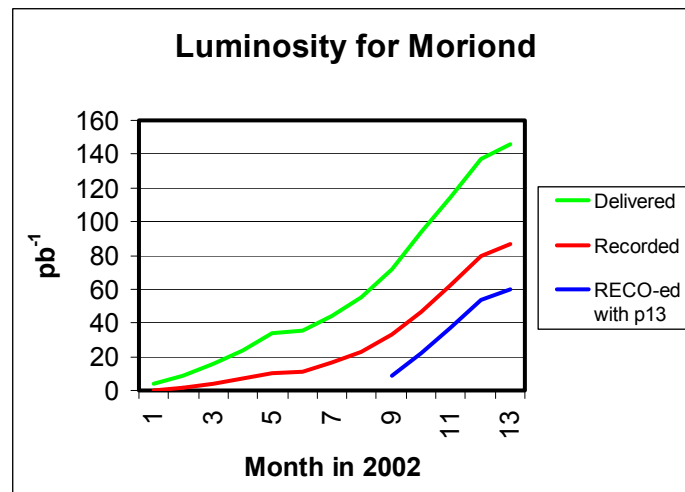
but we have to remember that
there is future beyond Moriond (LP03, 2004, 2005, ...)

Where is the Physics?

The Challenge

- With $\sim 50 \text{ pb}^{-1}$ @ $E_{\text{CM}} \sim 2 \text{ TeV}$ we should be able to do interesting physics

But



- Our understanding of the data is continuously improving; this is a very complex experiment
- Many things came in late (data, MC, tmbs, tools, ids,...)

Stability

Tremendous challenge for the physics groups (24/7)



The Current Schedule

(As announced back in Oct. '02)

- Feb. 9 - Physics groups approval of results ✓
- Feb. 23 - EBs approval
- Mar. 8 - La Thuile (3/15 - Moriond)

We are still in the thick of things -
nothing yet is finalized or approved

We're getting there!

Editorial Boards for Run II Analyses



- We formed 10 EBs in to help us reviewing analyses for Moriond '03
- These EBs have been working in parallel with the physics groups (not ideal, but that's the reality now)
- The complete list:
 - **QCD:** Heidi Schellman (chair), Vivian O'Dell, Alberto Santoro, and Mike Strauss
 - **WZ:** Stefan Soldner-Rembold (chair), Ursula Bassler, Gregorio Bernardi, and Terry Wyatt
 - **B:** Rick Jesik (chair), Alice Bean, Hal Evans, and Yuri Yatsunenko
 - **Higgs:** (W/Z \rightarrow e)+Jets - Bing Zhou (chair), Marie-Claude Cousinou, Peter Mattig, and Ron Madaras
 - **Higgs:** (W/Z \rightarrow μ)+Jets - Herb Greenlee (chair), Karl Jakobs, Linda Stutte, and Daria Zieminska
 - **Higgs:** H \rightarrow WW, $\gamma\gamma$ - Drew Baden (chair), Sue Blessing, Ron Lipton, and Dorothee Schaile
 - **Top:** Production Cross Section - Chip Brock (chair), Mike Diesburg, Martin Grunewald, and Serban Protopopescu
 - **Top:** Mass - Harry Melanson (chair), Bill Lee, Scott Snyder, and Armand Zylberstejn
 - **NP:** SUSY - Elemer Nagy (chair), Barbro Asman, Laurent Duflot, and Naba Mondal
 - **NP:** Contact Interactions - Uli Heintz (chair), Pushpa Bhat, Adam Lyon, and Peter Ratoff

They are doing a very important job - thanks!

Results for Moriond

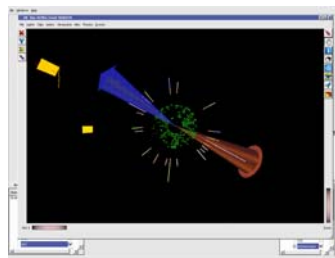


- I won't steal the thunder from Friday presenters
 - Top - Lisa Shabalina
 - QCD - Alexander Kupco
 - NP - Adam Yurkewicz
 - B - Tulika Bose
 - Higgs - Peter Tamburello
 - WZ - Sean Mattingly
- They represent the hard work (and sleepless nights) and ingenuity of many people
- Kudos to the convenors for ably shepherding these major efforts under difficult circumstances



**Come early on Friday (8am!) and enjoy -
the results are exciting**

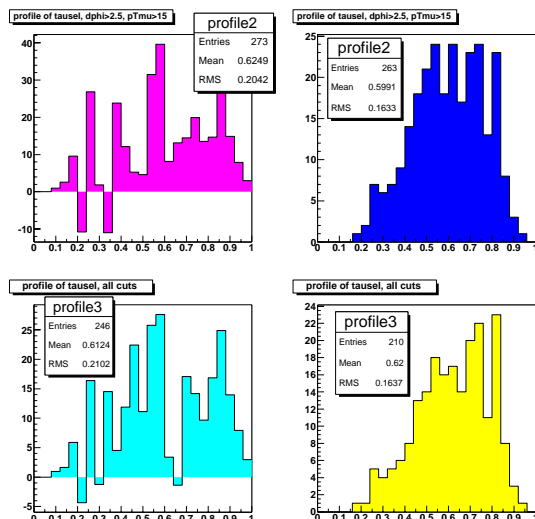
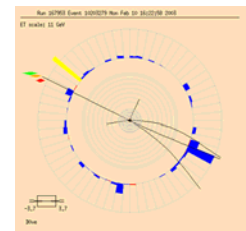
Just a flavour of what's coming



Late-Breaking News

evidence for $Z \rightarrow \tau\tau$

$$(Z \rightarrow \tau\tau \rightarrow \mu\nu_\mu\nu_\tau + \text{had})$$



Number of $\mu\tau$ events applying successive cuts

Cuts	DATA			$Z \rightarrow \tau\tau$
	$\begin{smallmatrix} +- \\ -+ \end{smallmatrix}$	$\begin{smallmatrix} ++ \\ -- \end{smallmatrix}$	opp - 1.04* eq	50 pb^{-1}
$p_T^\mu > 7 \text{ GeV}$	25138	22999	1218^{+220}	405^{+40}
$p_T^\mu > 15 \text{ GeV}$	3209	2719	381^{+70}	212^{+30}
$ \phi_\mu - \phi_\tau > 2.5$	1893	1557	273^{+59}	200^{+30}
1 prong	1141	860	246^{+45}	151^{+20}
prof.>0.6	355	210	136^{+24}	100^{+15}

There is compelling evidence of $Z \rightarrow \tau\tau$ in events with high p_T (>15 GeV) isolated μ 's and reconstructed τ candidates.

- Great start - many physics processes will benefit
 - W/Z, Higgs, Top, NP searches,...
- Soon we'll have the proper triggers in place (CTT)

...and a taste of the physics results

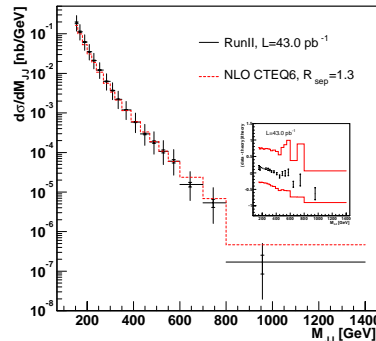


QCD



$$M_{jj} = 926 \text{ GeV}$$

$$\sqrt{s_T} = 26 \text{ GeV}$$

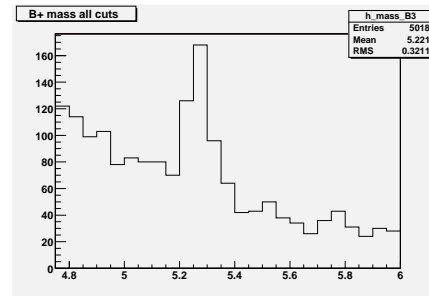
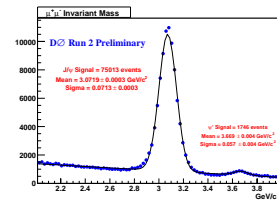


differential dijet
mass cross section



B

A nice sample
 $\sim 75K \text{ J}/\psi, \sim 1.7K \text{ } \psi'$



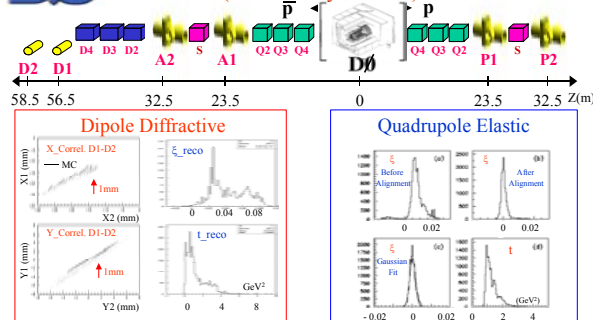
$B^+ \rightarrow J/\psi + K^+$ mass

B^+ lifetime?

Other mass peaks?

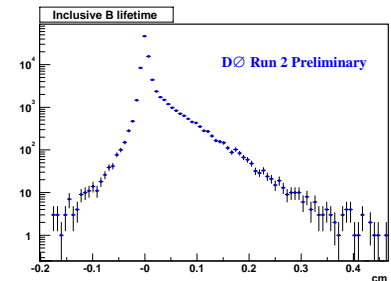


Forward Proton Detector
(Preliminary Results)



First diffractive
events in FPD!

B lifetime
(using J/ψ)



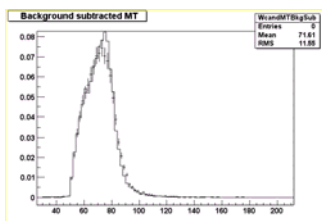
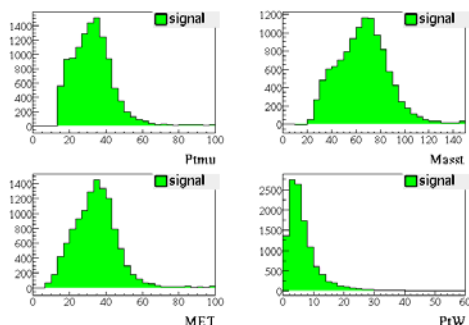
$$452 \pm 6.2 \text{ (stat)} \pm 44 \text{ (syst)} \mu\text{m}$$

PDG: 469 ± 4

...and a little more...

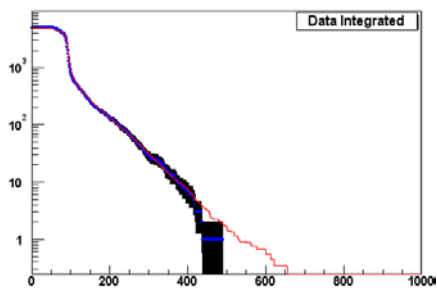
WZ

$\sim 75K W \rightarrow \mu\nu$



$\sim 28K W \rightarrow e\nu$

$\sim 3K Z \rightarrow ee$

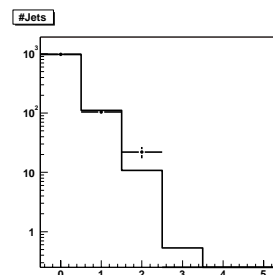
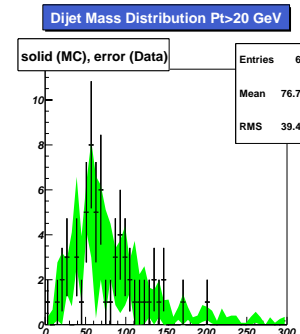


Z' search ; $m_{Z'} > \sim 600 GeV$



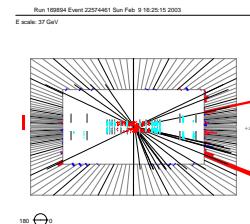
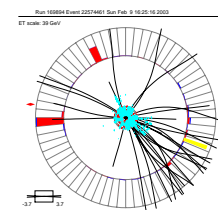
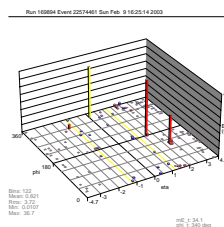
Higgs

$ZH \rightarrow \mu\mu + jets$



$ZH \rightarrow ee + jets$

$WH \rightarrow e/\mu\nu + jets$ in the works too



$H \rightarrow WW \rightarrow e\nu e\nu$



...and finally ...

Top

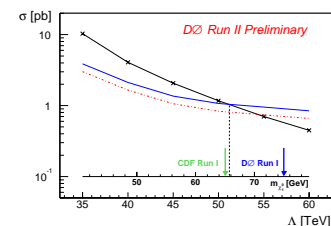
Convenors: "Candidates in every channel, with 3 different b-tagging methods for $l+jets$. We have background estimates, efficiencies and expected number of events but things are still changing, and we would prefer to settle on some of the numbers in the next couple of days. Lisa should be able to show our final numbers on Friday".



NP

GMSB

$(\gamma\gamma/\tau)$



Extra Dimensions

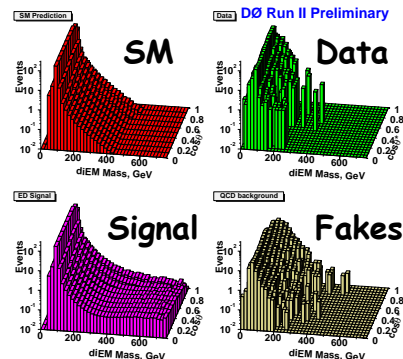
$M_S > 1.13$ TeV

DØ (Run I) - 1.2 TeV

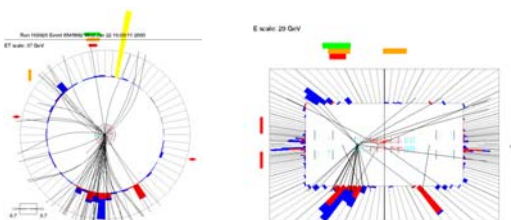
CDF (Run I) - 1.0 TeV

LEP exp. ~ 1.1 TeV

LEP comb - 1.2 TeV

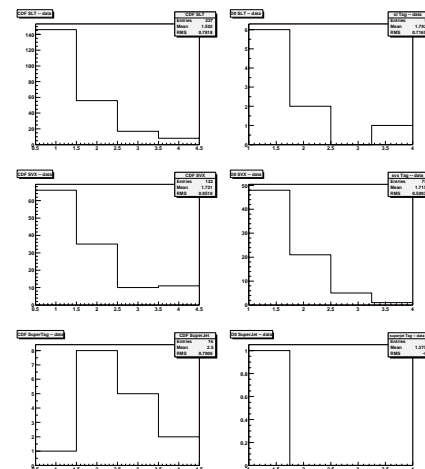


$t\bar{t} \rightarrow e\mu jj$ candidate



e	$P_T = 20.3$ $\phi = 5.22$ $\eta = 1.09$ Charge=1
μ	$P_T = 58.1$ $\phi = 1.74$ $\eta = -0.44$ Charge=-1 Halo=0.6 TrHalo=0
j	$P_T = 141.0$ $\phi = 4.57$ $\eta = -0.335$
j	$P_T = 55.2$ $\phi = 2.39$ $\eta = -0.97$

We see no evidence for extra Superjets (a la CDF)



X-section on Friday?

Where are we heading now?



The Next Six Months (tentative dates)

Need to add overall goals for the experiment
e.g. Data-taking efficiency >85%, CTT, TARC, OATF, ...

- Mar. 10 - p14 (RECO & MC) ready for the farms
- Apr. 5 - APS/DPF meeting (Philadelphia)
- May 10 - Certified Ids for p14
- May 31 - Certified JES for p14
- June 11 - End of data-taking period for LP03
- June 27 - End of data-processing period
- July 18 - Physics groups approval of results
- Aug. 11 - Lepton-Photon 2003 @Fermilab

Still a tight schedule, but a little better for
the end-game (provided we stick to this...)

Longer-Term Thoughts/Plans

- Publications

- Good “enough” understanding of our data
- Impact on HEP community

We have a few candidates for this summer

- It's time to start thinking about the next several years

- Physics goals, e.g. *W mass, measurements with τ 's, Higgs,...*
- Hardware requirements (performance, stability,...)
- Software/Algorithms needs
- Analysis organization & (wo)manpower
- Computing
- Documentation

A nice theme for the summer workshop?

Conclusions



- Exciting physics is just around the corner!
- Tremendous progress made in many areas over the last several months
- Major accomplishments; seeds for promising future
- We are seeing signals of all the physics we're interested in (so far except for Higgs & NP...)
- We measure cross sections, masses, limits, etc
- The next several months (and years!) are going to be very interesting to all of us

Let's converge on Moriond analyses and get ready to produce even more exciting Physics results in the near future.

Just a reminder - this is the most exciting place for HEP research in the next 7 years or so